EXECUTIVE SUMMARY OF FINAL REPORT

I. CONCLUSION AND RECOMMENDATION

1. Nepal aims to establish a long-tem self-supply of electricity by utilizing its hydropower potential. Hydropower generation in Nepal amounts to 528MW (90%) of the total electricity supply facilities of 585MW in FY2001/02. Run-of-river type hydropower stations produce 436MW (74%) of the power generation. Their power outputs are affected by river flow, resulting in a drastic decrease of power generation in the dry season. In the past, 10MW to 60MW of load shedding occurred from 17:00 to 22:00 in the evening of the dry season. After commissioning Kaligandaki A Hydropower Project in March 2002, the load shedding decreases at present. However, new power sources are needed to cope with the increasing peak power demand in the near future. Nepal is not intending to introduce thermal plants in view of power security. Under such circumstances, Nepal imports electricity from India and scatters the application of load shedding of 50 to 100MW in the dry season, but to cope with the shortage of peak electricity power under these conditions, the development of peak power stations is needed.

   The Kulekhani cascade project consisted of a reservoir type power station of 60MW (Kulekhani I) and a run-of-river type power station of 32MW (Kulekhani II) to supply reliable peak power in an integrated power system during the dry season by utilizing the seasonally regulated water in the Kulekhani reservoir. The Kulekhani III Hydropower Project (The Project) is also envisaged as a peak power station by using seasonally regulated water released from the Kulekhani reservoir as a final stage of the Kulekhani cascade project.

   The Upgrading Feasibility Study on the Kulekhani III Project concludes that the Project is developed as a peak power station of regulating pond type with an installed capacity of 45MW, bearing in mind the above circumstance in the system, and the need for the reliable supply of peak power in the dry season.

Item	Results of Study
1) Optimum development scheme	Underground power station of regulating pond type with 475,000m^3
2) Installed capacity and annual energy production	45MW and 47.3GWh/year
3) Project cost and construction period	US$ 78 Million and 3.5 years
4) Economic and financial values	EIRR of 15.3% and FIRR of 5.0 %

   The study of the input timing of the Project into the integrated power system reveals that the Project's power generation needs to be commissioned in 2007 to meet the peak power and energy demands, even though the power of 100MW is imported from India. Further, it is necessary to input the Project in the system in 2008, even if the power is

imported from India up to the maximum limit of power exchange of 150MW, being not reliable power. A study on the effect of the Project feeding into the system revealed that the Project could supply peak power for four hours in the evening to prevent the power deficit in the dry season of FY2007.

In the Tenth Development Plan, the Government of Nepal has a position that the reliable electricity supply is apprehended as important to achieve both national economic development and nation-wise equitable development. In this line, the development of the Kulekhani project is given to the first priority as the project that can supply the reliable peak power to the demand center. In addition, the Nepal Electricity Authority (NEA) nominates the Kulekhani III Hydropower Project as the first priority project in the Corporate Development Plan in 2002, and aims at commencing its power generation in 2007. Accordingly, the implementation of the Project is recommended as early as possible by proceeding to the detailed design in 2003 following acceptance of this Upgrading F/S.

II. THE STUDY

Background of the Study

2. The electricity energy and peak power demands in Nepal have been increasing from 981GWh in 1992 to 1,868GWh in 2001, and from 216 MW in 1992 to 391 MW in 2001. The average annual growth rates of energy supplied and of peak load are 7.41% and 6.82% over the last ten years. The annual growth rate will continue to be as high as 8%.

The total electricity supply facility in Nepal is 585MW in FY2001/02, and hydropower generation in Nepal amounts to 528MW (90% of total). Run-of-river type hydropower stations occupy 436MW (74%) of total power supply. Nepal has a shortage of peak power supply due to a decrease in power generation from run-of-river hydropower stations during the dry season, when river runoff decreases. Nepal imports electricity power from India and carries out load shedding.

Under such circumstance, the Nepal Electricity Authority (NEA) has prepared a generation expansion plan for hydropower facility alone to meet the energy and peak power demand, taking into account the policy of effective development of abundant hydropower potential in Nepal and power security. There are no fossil fuel resources of oil and coal in Nepal, all of which are imported.

The study on the Kulekhani Overall Development Project in 1974 adopted a river diversion scheme by constructing a 114m high rockfill dam in the Kulekhani River and diverting the water regulated in the reservoir to the Upper Rapti River. The Kulekhani project is located about 30km southwest of Kathmandu. It incorporates a cascade plan for developing three hydropower projects, harnessing a water head of 1,040m and the river flow is diverted from the Kulekhani River to the Upper Rapti River as follows:

- the Kulekhani I hydropower station having a water head of 600 m, an installed capacity of 60MW and an annual energy production of 162GWh, constructed from 1977 to 1983,
- the Kulekhani II hydropower station having 310m water head, 32MW installed capacity and 105GWh annual energy, constructed from 1982 to 1986, and
- the Kulekhani III hydropower station harnessing 130m water head, 17MW installed capacity at that time.

Both Kulekhani I and II hydropower stations (total installed capacity of 92MW) play a role in peak power generation owing to the Kulekhani dam having a seasonal reservoir regulating capacity, together with small scaled diesel power plants. However, the peak power demand still can not be satisfied. The NEA is obliged to execute load shedding of 50 to100 MW in the dry season.

To cope with the deficit of peak electricity power in the dry season, a plan for the Kulekhani III Hydropower Project was formulated. Six alternatives have been studied from 1987 to 1999. When the Project implemented, the power station would operate as a peak facility with the capacity to supply peak power for 4 hours in the evening by utilizing runoff seasonally regulated by the Kulekhani reservoir.

His Majesty's Government of Nepal requested the Government of Japan to carry out the feasibility study (F/S) and the detailed design (D/D) in October 2000. The NEA intends an early input of the Kulekhani III Hydropower Project into the integrated power system in order to reduce the shortage of peak power in the dry season. The Upgrading Feasibility Study of the Project has been carried out from September 2001 to February 2003.

Objectives of the Study

3. The purpose of the Study is to: 1) review the updated Feasibility Study of the Kulekhani III prepared by the Nepal Electricity Authority (NEA), and 2) study the feasibility of the Project by carrying out supplementary geological investigation, supplementary environmental impact assessment, and formulating the optimum development plan from technical, economic, financial, and environmental viewpoints. The Study aims at the transfer of technology to the Nepalese counterpart personnel in the course of the Study.

Progress of the Study

4. The Study was carried out three stages, Preliminary Investigation Stage, Detailed Investigation Stage, and Design and Economic Evaluation Stage with phases of field preparatory work, home preparatory work, five field investigations and three home office works during the period of 18 months from September 2001 to February 2003. The overall work schedule is summarized as follows:

Study Stage and Phase	Work Period	Report Submitted
Preliminary Investigation Stage		
• Field Preparatory Work	September to October 2001	
• Home Preparatory Work	October 2001	Inception Report
• First Field Investigation	November to December 2001	
• First Home Office Work	January 2002	Progress Report
Detailed Investigation Stage		
• Second Field Investigation	February to March 2002	
• Third Field Investigation	June to July 2002	
• Second Home Office Work	July 2002	Interim Report
Design and Economic Evaluation Stage		
• Fourth Field Investigation	August to November 2002	
• Third Home Office Work	December 2002	Draft Final Report
• Fifth Field Investigation	December 2002	
	February 2003	Final Report

III. SOCIO-ECONOMIC SITUATION

Socio-Economy

5. Nepal is an inland developing country situated between the great plain of India and the desert-like plateau of Tibet. Its area is 147,181 km^2. The population is 22.7 million with an annual growth rate of 2.1% from 1991 to 2000. Over 85% of the people live in rural areas and mostly depend on subsistence farming. The GDP per capita for the year 2000/01 is US$ 243. The average annual per capita growth rate of GDP from the year 1990/01 to 2000/01 was 2.91%.

National Development Plan

6. Nepal commenced its national development plan in 1956 with the First Five Year Plan (1956 to 1961). Nine periodic plans have been implemented, and the Tenth Five-year Plan (2003 to 2007) has commenced. The target annual growth ratio of GDP was 6% for the Ninth Five Year Plan, however, the actual growth ratio of the period was lowered to 4.29% due to slack in basic overall sectors. In the Tenth Plan, poverty alleviation is the main object with the target to reduce the ratio of the population below the poverty line from the current level of 38% to 30%. The annual growth ratio of GDP targets 6.2% in the Tenth Plan.

   The electricity sector is apprehended as an important sector to achieve both national economic development and nationwide equitable development in the Tenth Development Plan. The plan regard the supply of reliable and quality electricity services is one of the most important infrastructure categories to be provided to enable the development of the information technology, industry and commerce sectors.

Social and Economic Forecast

7. Economic indicates were estimated for the power demand forecast in an integrated power system in Nepal by taking into account of the methodology and economic adopted indicators of NEA's load forecast in 2002, those in the Power System Master Plan for Nepal in 1998 by the Asian Development Bank (ADB), and the actual performance of the economic growth as follows:

Indicators	Average Annual Growth Ratio
Population	2.1%
GDP	6.0%
GDP/capita	3.8%
Industry	7.3%
Commerce	6.5%
Other Sectors	5.5%

IV. POWER SURVEY

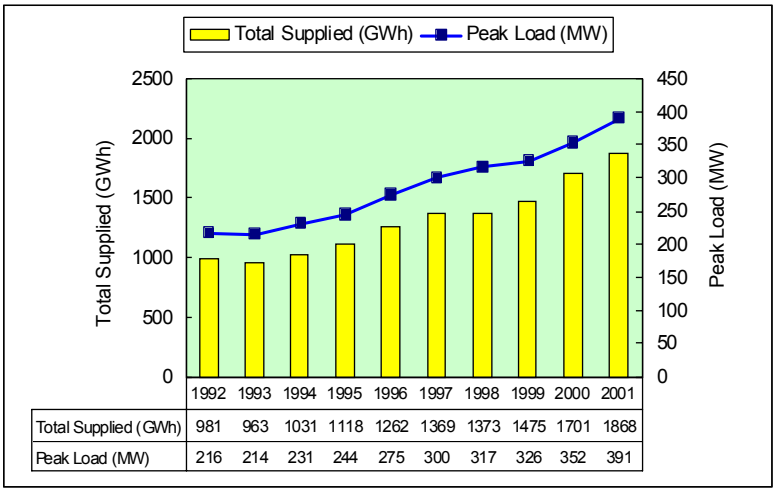
Existing Power System and Development Plan

8. The annual energy production in Nepal reached 2,088GWh in the fiscal year of 2001/02 with an increase of 11.8% from 1,868GWh in FY2000/01. This consists of 1,117 GWh by hydropower, 18 GWh by diesel, and 953 GWh by purchase from independent power producers. The imported energy from India totaled 238GWh. The total installed capacity in FY2001/02 was 584.6MW, consisting of 395.2 MW by major hydropower, 19.0MW by small hydropower, 56.7MW by diesel, 0.1 MW by solar energy, and 113.6MW by independent power producers.

	Power Source	Installed Capacity (MW)	Available Energy (GWh)
1.	Major Hydropower	395.2	1,117
2.	Small Hydro	19.0	
3.	Independent Power	113.6	953
	Subtotal	527.8 (Run-of-river 435.5)	2,070
4.	Diesel	56.7	18
5.	Solar Power	0.1	
6.	Import from India		238
	Total	584.6	2,326

Data source: NEA"FY2001/02 A Year in Review" in August 2002

The whole energy supplied in a year and the peak demand from FY1991 to FY2000 is shown as follows:



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total Supplied (GWh)	981	963	1031	1118	1262	1369	1373	1475	1701	1868
Peak Load (MW)	216	214	231	244	275	300	317	326	352	391

Energy Supplied and Peak Load from FY1992 to FY2001

The energy production and peak load of the Nepal Electricity Authority (NEA) have grown at an annual rate of 7.50% and 7.93% over the last ten years. The annual growth rate will continue to be about 8%. The breakdown of energy consumption into household customers, industrial customers and others for FY2000/01 was 37%, 38% and 25% respectively. The electrification ratio of Nepal still remains at 15%. The average power tariff in 2001 is estimated at NRs.6.23/kWh equivalent to 8 US ¢ /kWh.

According to the demand forecast of the NEA annual report for the fiscal year of 2001/02, the energy demand is expected to reach 2,598GWh and 3,855GWh in FY2005 and FY2010, and the peak power, 570 MW and 846 MW in 2005 and 2010.

Fiscal Year	Energy (GWh)	Peak Power (MW)
2002	2,088	426
2005	2,598	570
2007	3,094	679
2010	3,855	846
2015	5,456	1,198
2020	7,668	1,683

Data source: NEA"FY2001/02 Year in Review" in August 2002

The theoretical potential of hydropower development in Nepal amounts to 83,600 MW. Out of the theoretical potential, 43,000 MW can technically be developed. His Majesty's Government of Nepal has a plan of developing the hydropower potential, aiming at a long-term self-supply of electricity and exporting the surplus power to India. The NEA intends to develop hydropower stations totaling 383 MW by the year 2007. The Kaligandaki-A Hydroelectric Project of 144 MW commenced its power generation at the end of March 2002, and the Middle Marsyandi Hydroelectric Project of 70 MW is planned for completion in 2005.

9. The NEA is updating the generation expansion plan, taking into account the generation expansion plan of the ADB master plan in 1998, and the progress of power stations under construction. The latest generation expansion plan of NEA as of December 2001 is given in Table S.1.

Power Demand Forecast

10. The energy demand predicted by NEA can be adopted as a result of a review of the latest demand forecast of NEA in July 2002 (average growth rate of 7.8% from 2001 to 2020). Taking into account of the load factor restrained by load shedding, the peak power demand will be slightly increased by adopting the average growth rate of 8.3% from 2001 to 2020 with the load factor of 50%. The forecasted energy and peak demands from 2003 to 2020 are shown as follows:

Fiscal Year	Energy (GWh)	Peak Power (MW)
2002	2,087	426
2005	2,652	606
2007	3,154	720
2010	3,927	897
2015	5,553	1,268
2020	7,799	1,781

The energy and power demands and the supply balance are shown in Figure S.1, considering the results of the demand forecast and generation expansion plan of the NEA.

V. SITE CONDITIONS

Location and Topography

11. The project area of the Kulekhani III hydropower station is located in the Rapti River basin along 6 km long reach from Bhaisedobhan to Hetauda in Makwanpur District. The Rapti River, which meets with the Khani River at Bhaisedobhan, flows from northeast to southwest. In the upstream stretch from Bhaisedobhan to the confluence of the Kesadi River, one of the tributaries of the Rapti River, the river slope is steep at 1/50 to 1/100. The slope of the river downstream of the confluence of the Rapti River and the Kesadi River to Hetauda is gentle in comparison with the upstream stretch affected by the geological characteristics of Siwalik. A principal mountain ridge stretches in the direction of northeast to southwest, showing a rugged and steep relief. The highest peak rises to 1,300 m above sea level and the lowest point is approximately 500 meters near the town of Hetauda.

Meteorology and Hydrology

12. The inflow into the existing Kulekhani reservoir and the runoff of tributaries were estimated by runoff analysis in order to identify the potential water available for power generation. The estimated long-term annual average inflow into the Kulekhani reservoir is 4.36 m^3/sec, based on 33 years of record from 1963 to 1995. This discharge consists of 1) runoffs recorded at Kulekhani gauging station (126km^2) from 1963 to 1977, 2) runoffs estimated by utilizing rainfall records and Tank Model from 1978 to 1982, and 3) runoffs computed by means of reservoir operation simulation, since recorded runoffs are limited from 1963 to 1995. The flow-duration curve of the inflow into the Kulekhani reservoir is shown in Figure S.2.

13. The design flood discharge at the Khani headworks, the Yangran regulating dam and the tailrace outlet was estimated at 470m^3/sec, 280m^3/sec and 1,810m^3/sec respectively.

14. The annual sediment volume into the Yangran regulating pond was estimated at 19,000m^3/year equivalent to the sediment load of 2,300m^3/km^2/year by computing the annual sediment volume into the Kulekhani reservoir on the basis of the sediment record in the Kulekhani watershed from 1993 to 2000. This was obtained by taking into account the characteristics of both the Kulekhani and Yangran watersheds.

Geology

15. The geology of the project area mainly consists of marble, siliceous dolomite, schist, quartzite, phyllite, slate and sandstone. Two major thrust faults of the Mahabarat Thrust (MT) and the Main Boundary Thrust (MBT) cross the project area from WNW to ESE (Refer to Figure S.3).

16. The underground cavern of the powerhouse is placed in a siliceous dolomite layer of 150m thickness within a ridge on the right bank of the Rapti River. Core drillings in the exploratory adit show that the siliceous dolomite at the planned underground powerhouse is fresh and sound rock. The possibility of construction of the underground powerhouse was examined by the cavern analysis on the basis of rock properties obtained by in-situ rock tests, drilled core, uniaxial compressive strength, geological conditions along the exploratory adit from overall viewpoints. This also takes into account the rock classification of Q system and the Central Research Institute of Electric Power Industry (CRIRPI) in Japan. The cohesion strength of 2 to 3MPa and the friction angle of 45 to 50 degrees are adequate in the rock mass around the underground powerhouse cavern.

17. The bedrock of the proposed regulating dam site consists of phyllite. The results of core drillings suggest that the phyllite is generally hard, with low permeability, except for a moderately weathered layer of 1 to 5m thickness.

18. The 3.5km connection tunnel along the Rapti River diverts through marble, schist, quartzite, phyllite and siliceous dolomite. Most of the tunnel routes consist of intact rocks. No serious problem is envisaged for the stability of tunnel faces, however, lithological boundaries at the Mahabharat Thrust (MT) will be fractured and altered to clay. Groundwater ingress also appears to be encountered in such boundary sections.

    The 0.4km long headrace tunnel is planned on the right bank of the Rapti River. Phyllite and siliceous dolomite are encountered along the tunnel route. The boundary of two strata might be fractured judging from the outcrops observed along the river.

    The 2.1km long tailrace tunnel crosses the Main Boundary Thrust (MBT) in the bed of the Kesadi River. Paleozoic slate, Tertiary Siwalik sandstone of Cenozoic and alluvium of unconsolidated riverbed material would be encountered in the course of excavation work. Slate and sandstone are fractured and in poor condition in and around the MBT. Therefore, a culvert type waterway of 400m in length is recommended in the section crossing the MBT in the riverbed of the Kesadi River.

    As explained above, careful attention to the detailed design and excavation works of the three tunnels will be required at the lithological boundaries of the MT and MBT due to fracturing, presence of clay and possible groundwater ingress.

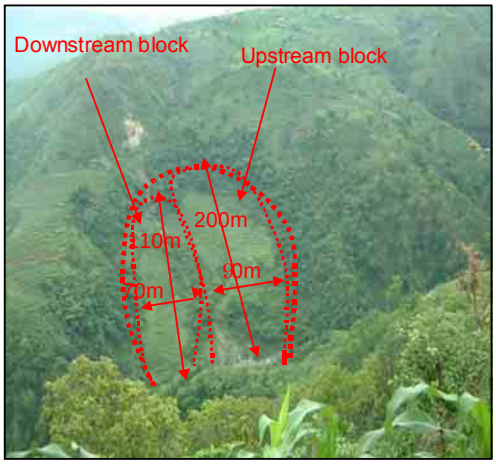
19. The project area is located in an active tectonic zone, with thrust faults of the Himalayan foothills causing a relatively high seismicity. Earthquake risk of the project site was evaluated by applying the maximum peak acceleration for the return period of 100years by Cornell and Kawasumi formulas, based on earthquake records of 153 earthquakes obtained from US Geological Survey. This takes into account the

maximum peak acceleration, the maximum credible earthquake, and NEA's seismic risk study for the feasibility study in 1988. As a result of evaluation, the appropriate design earthquake acceleration is considered to be 0.15g.

20. Aggregates for concrete are distributed in front of Kulekhani I power station in the riverbeds of the Rapti River in the project area. As a result of investigation on the available volume and the laboratory test of distribution of grain, the available volume of coarse aggregate was estimated at more than the requirement of 150,000m^3. Sand for concrete should be mechanically crushed by rod-mil. Raw materials of sand will be obtained in the riverbed of the Rapti River. Cement for concrete will be imported, while major construction materials of reinforcement bars and wood can be procured in Nepal.

Landslides and Sedimentation in the Project Area

21. There are three landslides (R-1, R-2 and L-1) and six collapse areas in the Yangran regulating pond and the upstream basin. Landslide R-1 in the Yangran regulating pond consists of an upstream block and a downstream block. The stability analysis of landslides based on the geological investigation indicates that excavation of the head and construction of an embankment at the toe are needed to maintain stability of the downstream block. Landslide R-2 is located at 1.5 km upstream from the regulating pond. There is a possibility of large scaled landslide developing behind Landslide R-2. Detailed topographic survey and geological investigation are needed to find the size of landslide and the appropriate countermeasures against Landslide R-2. Landslide L-1 at the left bank of the regulating pond appears stable enough. Slope protection is needed on the collapsed area of the upstream block. Two check dams are needed to be placed in the upstream reach of the Yangran River as countermeasures against sediment in the regulation pond in consideration of slope failures in the Yangran basin and its characteristics.



Landslide R-1 in Regulating Pond

Landslide R-2 of 1.5km upstream from Regulating Pond

22. The project area is situated in the Rapti River, immediately south of the Kulekhani River basin. The Kulekhani and Rapti basins are composed of quartzite surrounding the Pre-Cambrian Bhimphedi Group, Lower Paleozoic Phulchaki Group, and Nawakot Complex. Debris flows and slope failure disaster occurred in 1993 in the area of quartzite and their terrace deposits (Refer to Figure S.4). Three check dams to protect against debris flow and slope failure were constructed in the Kulekhani reservoir basin after the 1993 disaster. The site reconnaissance in the Kulekhani watershed observed that Check Dam D1 in the Darkot River at the right bank of the reservoir has been filled by river deposits. Boulders produced by debris flow are deposited in the upstream reach of the Kulekhani River from Check Dam No.1 to the Kiteni River. Two additional check dams are needed, one at the upstream reaches of D1 in the Darkot River, and the other in an upstream reach of the Kulekhani River.

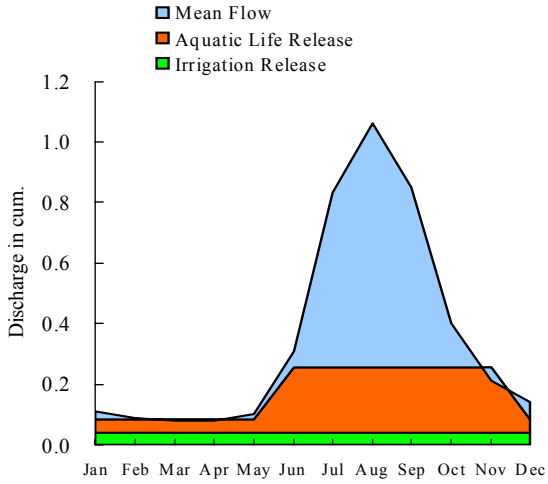
VI. ENVIRONMENTAL IMPACT ASSESSMENT

Natural Environmental Impact Assessment

23. The supplemental environmental impact assessment survey (the supplemental EIA survey) in this study is shown in Table S.2 and S.3, and Figure S.5 as a result of reviewing the existing EIA.

24. The natural environmental impact imposed by the Project will be aquatic ecology and fisheries, and fauna and flora in the Yangran River and the Khani River where their natural runoffs are reduced by constructing the regulating dam and headworks. The results of the supplemental natural EIA survey in both dry and rainy seasons (water quality, fauna and flora surveys, fisheries and aquatic ecology) indicate that the impact on the natural environment by implementing the Project would be less.

25. The river maintenance flows were studied for the Khani River and the Yangran River where the Project diverts natural runoff to the waterway for power generation. The headwork of the Project is located at the Khani River 300m upstream of the confluence with the Rapti River. The impact on the river ecology would be less in the Khani River. The Yangran regulating dam will be constructed at the middle reach of the Yangran River (Basin area: 8km^2). The study of river maintenance flow refers to existing concepts in the Medium Hydropower Project Study in 1997 and the Melamchi Water Supply Project as good practice. The irrigation water of 0.04 m^3/sec is taken for use in Sanutar and Gumaune Villages. The river maintenance flow was studied by taking into account the irrigation water of 0.04 m^3/sec and the minimum requirement for keeping the aquatic life as the natural river maintenance flow. As a result, the maintenance flow is proposed 0.1 m^3/sec in the dry season and 0.3m^3/sec in the rainy season by applying the 90% dependable discharge in both seasons as the minimum requirement.



River Maintenance Flow in Yrangrang River

26. Tunnels of 7km total length and the underground cavern might introduce environmental impacts on domestic water supplies of spring water and surface water in villages in the project area. Construction of the tunnels and underground cavern will lower the level of ground water and reduce the discharge of spring water. In order to

avoid this potential problem, the location of spring water and surface water, their use, and their discharge were investigated in both rainy and dry seasons. The results of the spring water survey in both dry and rainy season show that there are 23 permanent spring water supplies and three temporary spring water supplies serving 213 households with drinking water, livestock water and occasionally irrigation.

Social Environmental Impact Assessment

27. The social environment impacts are: 1) resettlement and land acquisition in Sanutar and Gumaune Villages, where the access road and temporary facilities will be constructed, 2) the impoundment of the regulating pond area in the Yangran River, 3) a limited amount of land acquisition on the Rapti River's right bank at the tailrace outlet, 4) the daily water release from the tailrace outlet, impacting about 4 km downstream on the Rapti River to the Hetauda Bridge.

28. An inventory survey was carried out to identify households and land acquisition in the project area as a part of the supplemental EIA survey fieldwork. GIS maps were prepared using aerial photograph maps of 1: 20,000 scale, cadastral maps of 1:2,000 scale, and the results of a GPS survey (Refer to Figure S.6). Resettlement and land acquisition were estimated, using the GIS map and on the basis of fieldwork at 25 households losing 26 houses and 15ha of agricultural land acquisition, affecting a currently estimated 72 households.

29. The Project will release a peak discharge of about 43.1m^3/sec during 4 hours from 5 p.m. and 9 p.m. for its peak power generation. The supplemental social EIA survey identified the impacts of the peak discharge on activities in the riverbed of the Rapti River (foot traffic over seasonal wooden bridges; small, seasonal water intakes for a number of irrigation projects; water mills, and miscellaneous uses such as washing clothes, bathing, ablution, vehicle washing, riverbed material collection, grazing animals, crossing the river). As a result, the following countermeasures against the downstream impact by releasing peak discharge are recommended:

- Installation of siren system for information of peak discharge release
- Provision of a suspension bridge at Maintar area on the Rapti River's Right Bank, 0.5km downstream from the tailrace, and moving of Sanutar's present suspension bridge to close by Hetauda, at Choke Tol near the NEA Diesel Power Plant
- Re-construction of three irrigation canals intakes and watermills for managing the peak discharge

30. The communities affected by the Project are situated from the intake to some 4 km below the tailrace area, at the Hetauda Bridge. Public consultation will be carried out

among these communities and with stakeholders in general, with maximum transparency, to assure public support both in the immediate preparation and construction phases and also in the long-term operational phase. The Project will explain the Project's principal feature and the Project's potential social environmental impact, as well as the planned mitigation measures, including the Resettlement Plan (RP), Social Action Plan (SAP), and Environmental Management Plan (EMP), for obtaining feedback and consensus. Taking into account these purposes, a Public Consultation Program will be implemented, consisting of:

- Clarifying affected communities and Project Affected Persons (APs) to be consulted,
- Identifying stakeholders,
- Presenting the pertinent aspects of the Project to the stakeholders, through various forms of media and by Public Consultation Meetings, and
- Soliciting the participation and cooperation of NGOs for assisting in public consultation and in designing the proposed mitigation programs

The substantive contents of the public consultation are summarized and its procedure is shown in Figure S.7.

31. The natural and social environmental mitigation and monitoring cost was estimated and are shown below:

	Items	Cost in US$ 1,000
1.	Natural Environmental Mitigation and Monitoring Plan (NEMP)	
1.1	Mitigation and monitoring measures during pre-construction	40.4
1.2	Mitigation and monitoring measures during construction	171.7
	Subtotal	212.1
2.	Social Environmental Mitigation and Monitoring Plan (SEMP)	
2.1	Resettlement Plan, Social Action Plan and Public Consultation during pre-construction	43.1
2.2	Mitigation measures during construction	
(1)	Resettlement plan (RP) including compensation for private land (15ha), houses (26houses) and compensation of trees	533.0
(2)	Social action plan (SAP)	545.3
(3)	Public consultation	16.4
	Subtotal	1,137.8
3.	Kulekhani Environmental and Social Management Unit (KESMU)	485.1
	Total	1,835.0

VII. PLAN FORMULATION

Optimum Development Scheme

32. The effect of the Project feeding into the integrated power system was examined. This study revealed that the Project is needed in the system for supplying peak power for four hours in the evening to cope with the power deficit by the dry season of FY2007 (Peak load of 762 MW). The result is presented in Figure S.8.

33. The optimum layout of the Project, from an economical viewpoint and as a result of reviewing the six alternatives proposed by the existing F/S, is a run-of-river type underground power station with regulating pond.

34. Five alternatives were studied to select the optimum project layout by considering 1) the geological condition of the underground cavern, 2) the countermeasures against landslides in the regulating pond and sediments in the Yangran River, and 3) the fractured and altered zone of the MBT in the bed of the Kesadi River for the tailrace. From the preliminary design, cost estimate and estimation of net present value (NPV), Alternative A-2 (Dam type regulating pond + Underground powerhouse + culvert type tailrace) is conceived as the optimum layout from an economical viewpoint. The optimum project layout is presented in Drawing. No.S.1 and S.2.

Alternatives	Headworks (HW)	Regulating Pond (RP)	Power Station	Tailrace	NPV Million US$
A	Khani HW	Yangran RP with dam	Underground	Tunnel	1,117
A-1	Khani HW	Yangran RP with dam	Semi-underground	Culvert	-0.001
A-2	Khani HW	Yangran RP with dam	Underground	Culvert	**1,119**
B	Khani HW	Underground RP without dam	Underground	Tunnel	-36,218
C	Khani HW	Distributed RP without dam	Underground	Tunnel	-14,596

Optimum Installed Capacity and Input Timing

35. The optimum installed capacity of the Project was studied by varying the peaking operation hour from 3, 4 to 5 hours, and estimating construction costs of the Project. The Study reveals that the optimum installed capacity is 44.8MW by the 4 hours peaking power operation, generating 47.3GWh/year by using the maximum discharge of 43.1m^3/sec as shown in Figure S.9.

36. The study of the input timing of the Project into the integrated power system shows that the Project needs to commission its power generation by 2007 to meet the peak power and energy demands in the power system.

Optimum Reservoir Operation

37. The optimum reservoir operation of the Kulekhani reservoir was studied by reviewing the existing operation rules and using the inflow into the reservoir for 33 years. In view of overall benefits, 4 months seasonal operation of the Kulekhani reservoir in the dry season, 8 hours daily peak operation of both the KL-I and the KL-II, and 4 hours daily peak operation of the KL-III are recommended as the optimum operation (refer to Figure S.10).

VIII. FEASIBILITY DESIGN

Feasibility Design

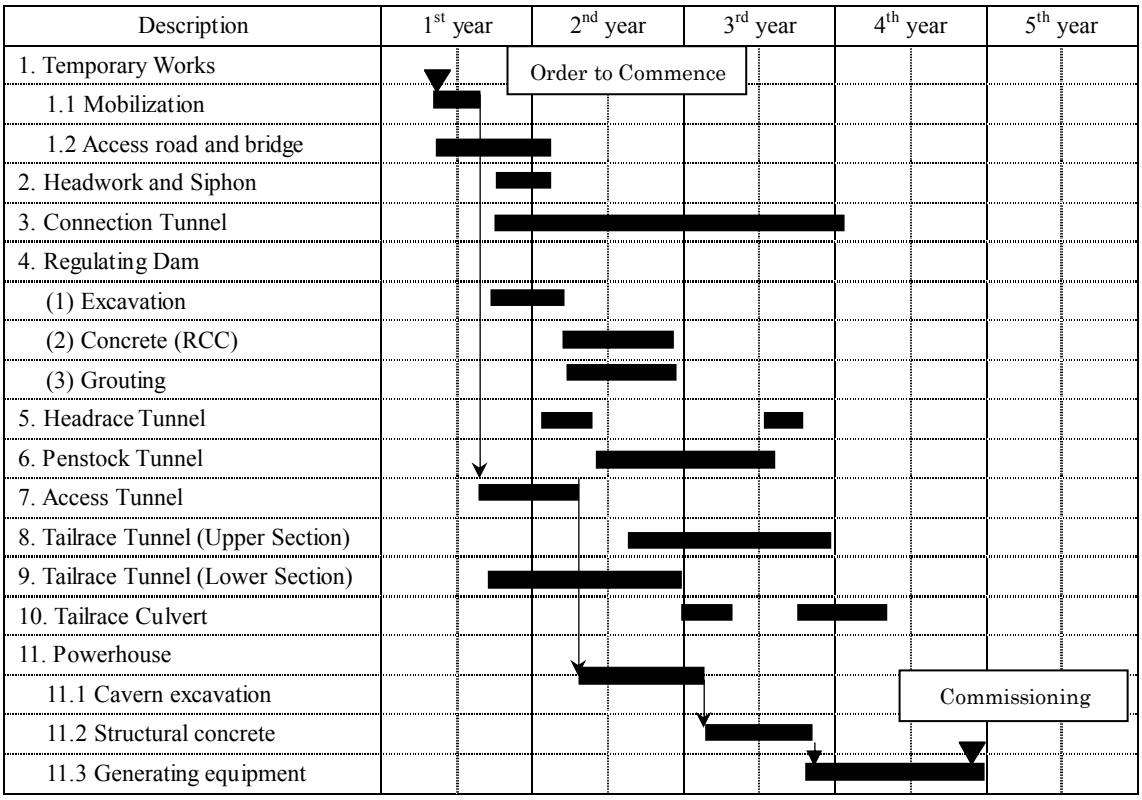
38. The feasibility design of the Project was carried out on a feasibility study level, and main features are summarized as follows:

Structures		Principal Features (Refer to DWG. No.S.1 to 6)
(1)	Khani intake	Headwork weir and intake
(2)	Waterway	
	Connection tunnel	Free flow type concrete lined tunnel, 3.25 m (D) and 3.5 km (L)
	Headrace tunnel	Pressure type concrete lined tunnel, 4.1 m (D) and 0.4 km (L)
	Penstock	Inclined/Horizontal Pressure Tunnel, Steel Lined
	Tailrace tunnel	Free flow type concrete lined tunnel and Culvert
(3)	Regulating dam	52 m high RCC dam, 475,000 m^3 regulating pond
(4)	Powerhouse	Underground Type, 17m (W), 31m (D) and 74m (L)
(5)	Generating equipment	
	Max. plant discharge	43.1 m^3/sec
	Rated head	118 m
	Number of units	Two
	Rated output	44.8 MW (2 x 22.4MW)
	Turbine	Vertical shaft Francis, 23 MW, 500 rpm
	Generator	3-phase, conventional, synchronous generator of vertical shaft with brushless excitation system, 26.4 MVA, 50 Hz
	Transformer	Indoor, special 3-phase, forced-oil-circulation water-cooled, 11 kV/132 kV voltage ratio, 26.4 MVA
	Switchgear	Indoor 132 kV GIS
(6)	Transmission line	132kV double-circuit, 2 km long connecting to existing 132 kV Hetauda to Siuchatar transmission line

IX CONSTRUCTION PLAN AND COST ESTIMATE

Construction Plan and Schedule

39. After completion of this Upgrading Feasibility Study, the detailed design and preparation of pre-qualification and tender documents will be carried out in the following 10 month period. The pre-qualification will be carried out for 5 months in parallel with the detailed design. Tendering will be executed for six months after pre-qualification. The main civil works will be commenced in June of the first year after the detailed design, and completed at the end of the fourth year after a 3 year and six months period. The Project can commence its power generation in December of the fourth year as below:



The construction schedule of the Project is shown in Figure S11. The critical path of construction works is placed on the access tunnel, underground powerhouse and installation of generating equipment. The construction of a temporary access road to the access tunnel is needed to be started just after the commencement of the main civil work contract in order to keep to the overall construction schedule.

Construction Cost

40. The project cost was estimated by means of unit price estimate method, considering site conditions, market prices of various construction resources, construction methods and work quantities derived from the feasibility design. The project cost comprises of:

1) Construction cost, 2) Engineering services and administration, 3) Environmental cost, and 4) Physical contingency and price contingency. The basic condition and assumption of the cost estimate are as follows:

(1) The price level of the cost estimate is July 2002 when the site investigation work was carried out.

(2) The cost estimate is made in US dollar (US$) for both foreign and local currency components.

(3) The exchange rate used in the cost estimate is US$ = NRs. 78.30 on July 16, 2002 by Nepal Rastra Bank.

(4) The construction work is assumed to be undertaken by competent contractors selected trough international competitive bidding (ICB).

(5) The rates of physical contingency is estimated at 10% of the total cost for civil works, environmental cost, administration expenses, and engineering services, while 5 % of metal works, generating equipment and transmission.

(6) The price escalation for foreign currency portion is assumed to be 0% per annum, which is predicted based on the G-5 MUV (Manufacturing Unit Value) Index published by World Bank. The price escalation for local currency portion is assumed to be 2.3% per annum, which is the escalation rate applied to the feasibility study on similar project in Nepal.

The project cost is estimated at US$ 77.7 million comprising of a foreign currency portion of US$55.8 million and local currency portion of US$21.9 million as summarized below:

Description	Foreign (1,000 US$)	Local (1,000 US$)	Total (1,000 US$)
1. Civil Works	29,844	12,522	42,366
2. Metal Works	4,500	500	5,000
3. Electro-Mechanical Works	13,228	1,113	14,341
4. Transmission Line	343	86	429
Total construction cost (1 to 4)	47,915	14,221	62,136
5. Administration (2.5% of 1 to 4)	0	1,553	1,553
6. Engineering Services (7.5% of 1 to 4)	3,594	1,067	4,661
7. Environmental cost	0	1,835	1,835
Base cost (Total of 1 to 7)	51,509	18,676	70,185
8. Physical Contingency	4,247	1,783	6,030
Total (1 to 8)	55,756	20,459	76,215
9. Price Contingency	0	1,474	1,474
Total Project Cost	55,756	21,933	77,689

The annual disbursement schedule is prepared on the basis of the project cost and the construction schedule as summarized below:

Indicators	Amount (US$ 1,000)
1st Year	11,492
2nd Year	27,528
3rd Year	30,923
4th Year	7,745

X. PROJECT EVALUATION

Economic Evaluation

41. The viability of the Project is examined through economic evaluation and financial analysis. The economic evaluation is conducted from the point of view of the entire society as a whole, based on the comparison of economic cost and economic benefit. Economic viability of the Project was assessed based on the feasibility design and the estimated construction cost. The economic cost is estimated at US$74.3 million by using a standard conversion factor (SCF) of 0.9.

42. The power generation pattern of the Project is particularly for the peak time operation. The generated power is reliable with the advantage of the location being near to the national energy consumption center of Kathmandu valley, where the nation's capital is located, and which accommodates the national economic center. These characteristics of the Project could be substituted by the alternative thermal plant. Therefore, the economic benefit is estimated by the conversion of the alternative thermal of a gas turbine for the firm peak energy and for the capacity through the alternative thermal method. The unit cost of the alternative thermal is derived based on US$ 660/kW and US¢11.73/kWh. The rest of the energy is estimated by the peak energy cost of the rainy season from the Long Run Marginal Cost (LRMC) of US$0.015/kWh, which is estimated by the ADB study in 1998. The economic benefit is derived by the capacity cost multiplied by the installed capacity (44.8 MW) and by the energy cost multiplied by the Project's output (47.3 GWh/year).

43. The result indicates a high viability of the development of the Kulekhani III Hydropower Project by the net benefit of US$ 23.8 million at a discount rate of 10% and the EIRR of 15.3%, which is higher than the opportunity cost in Nepal (10%).

44. The emission benefit is applied to the Project. The value of US$20 per ton is adopted as the emission penalty of CO_2, recommended by the World Bank. As a result of the economic analysis on emission benefit of CO_2, the EIRR is obtained at 16.0%.

The sensitivity analysis on the construction cost and fuel price is carried out for the case without emission benefit.

Items	Fuel Cost +10%	Base	Fuel Cost –10%
Construction Cost –10%	18.5%	17.8%	17.2%
Base	15.9%	15.3%	14.7%
Construction Cost +10%	13.9%	13.4%	12.9%

In addition, the case with a construction delay for one year by extending the construction period is examined and the EIRR is obtained at 14.0%.

The results of the sensitivity analyses show that the EIRR, for the worst case of the construction cost with 10% up, and the fuel cost with 10% down, exceeds the 10% value of the opportunity cost of the capital.

Financial Evaluation

45. The financial analysis is conducted from the point of view of the executing agency of the Project, NEA. The financial cost adopted for the financial analysis was derived by the project cost. The total project cost for the financial analysis is US$77.7 million. The gate price for the Project' electricity amounting to US$0.0711 per kWh is estimated based on the NEA's average tariff of NRs.6.81/kWh in FY 2002 equivalent to US$0.089/kWh, considering the increase of tariff price in real terms and peak tariff.

46. The FIRR of the Project is estimated at 5.0%, on the assumption that the commencement of the construction and the power generation of the Project are to be June 2004 and November 2007. The earning capability of the Project against the capital investment indicated by the FIRR of 5.0% is low. This value shows that even though the Project benefit is worth for the national economy compared to the project cost, the implementation of the Project is burdensome for the NEA in terms of finance. Therefore, the application of the subsidiary support for the Project from the Government is proposed in order to relax the burdensome led by the Project. The on-lent interest from Government to NEA is 10.25 % at present.

There ought to be several ways for the Government to support NEA including provision of a subsidized loan. Utilizing a soft loan from a donor country for the subsidized Project financing should be one of opportunities for the Government to realize it, which will allow marginal burden.

47. The sensitivity analysis of FIRR is carried out through examining the change of FIRR value varying the revenue and cost of the Project. The revenue and cost are assumed to change by 10%, and the resulted FIRR change is shown as follows:

Items	Revenue +10%	Base	Revenue –10%
Construction Cost –10%	6.2%	5.5%	4.8%
Base	5.6%	5.0%	4.3%
Construction Cost +10%	5.1%	4.5%	3.8%

The lowest FIRR value is 3.8% with a 10% increase in cost and a 10% decrease in revenue. The case of the construction delay for one year by extending the construction period resulted in a FIRR of 5.0%. Influence of the construction time extension is not significant to the FIRR calculation.

48. Loan repayability analysis is conducted to articulate the basic financial viability with a

soft loan, from a donor country, and an appropriate domestic loan interest rate for the Project implementation. Eight cases are taken for the above purpose as follows:

Case	Interest Rate	Brief Conditions
1	1.0%	Loan period of 30 years, 10 years grace period and 20 years repayment period for entire capital investment
2	1.0% for F.C 4.6% for L.C	Same as Case 1
3	5.0%	Local currency (L.C) portion is Equity Investment. Loan period of 24 years, 4 years grace and 20 years repayment
4	7.8%	L. C. Portion is Equity Investment. Principal Repayments of F.C is converted to Equity. (Loan period of 24 years, 4 years grace and 20 years repayment)
5	1.8%	Totally Loan Financed. (Loan period of 24 years, 4 years grace period and 20 years repayment)
6	7.5%	Case 3 with 10 year grace period (Local: Equity investment, Foreign: Financed, Loan period of 30 years, 10 years grace and 20 years repayment)
7	7.6%	Case 4 with 10 year grace period (Local: Equity investment, Foreign: Principal Repayment of F.C. is converted to Equity, Loan period of 30years, 10 years grace and 20 years repayment)
8	5.0%	Case 5 with 10 year grace period (Totally Loan Financed, Loan period of 30 years, 10 years grace and 20 years repayment)

The financial viability of the Project with a foreign soft loan is confirmed by Cases 1 and 2, since no liquidity problem is shown in these cases. Table S.4 shows the results of loan repayment analysis in Case 2.

Cases 3 to 7 analyze the viability of the on lent from the Government to NEA. These cases indicate the ceiling interest rates without liquidity problem for Project financing. Case 4 shows the highest interest rate of 7.8%, while Case 5 shows the lowest admissible interest rate. The results show that the equity investment share significantly affects the Project financing. It is also observed that the effect of grace period extension is greater at higher loan share. It is noted that Case 6 (the loan condition with 7.5% interest, the loan period of 30 years including a 10 year grace period and 20 years repayment) will not lead to overburden of the financial condition of NEA, and is a realistic on-lending condition.

49. As s result of the project evaluation, it is summarized that:

- The economic evaluation indicates that the Project is valuable for the nation, while the financial burden for the implementation of the Project is large to NEA.
- The utilization of a soft loan from a donor country is recommended, since the Project can supply reliable peak power to the demand center of Kathmandu, and the economic benefit of the Project to the national society is reasonably high.
- To materialize the Project, the support of the Government is needed for the financial subsidy such as a provision of on-lent loan with generous condition.

XI. TRANSFER OF TECHNOLOGY

50. The Transfer of Technology performed in the course of the Study consists of on-the-job training, presentation of the study results and counterpart training in Japan. For closing this assignment of the JICA Study Team, four presentations were held that focussed on the outcomes of First to Fourth Field Investigations relating to the Inception Report, Progress Report, Interim Report and Draft Final Report of the Feasibility Study.

XII. RECOMMENDATION FOR FURTHER STAGE

51. The current design has been prepared as a feasibility-grade design, therefore further elaboration to grade up to the level of detailed design will be required for the Project implementation. For further elaboration, the following additional engineering works will be required at the level of detailed design:

1) Additional field Investigations including aerial photographic survey in the project area, detailed topographic survey at major structure sites, and geological/geo-technical investigation,
2) Sediment study on the Yangran watershed consisting of field investigation and numerical simulations,
3) Hydraulic model test for the regulating dam regarding spillway and sand flushing facilities, and
4) Continue of the supplemental environmental assessment survey.

TABLES

Summary

Table S.1 Generation Expansion Plan of NEA

FY	Projects	Installed Capacity (MW)	Peaking Capacity (MW)	Average Energy (GWh/yr)	Comments
2002	Kali Gandaki-A	144	144	791	Under Construction
	Syange	0.1	0.06	1	IPP, PPA signed
2003	Chilime	20	20	101	IPP, Under Construction
	Indrawati	7.5	3	37	IPP, Under Construction
	Daram Khola	5	5	33	IPP, PPA signed
	Piluwa Khola	3	2	18	IPP, Under Construction
	Chaku Khola	0.91	0.9	7	IPP, PPA signed
2004	Pheme	0.95	0.9	8	IPP, PPA signed
	Upper Modi	14	8	89.6	IPP, Under Construction
	Khudi	3.5	2.2	25	IPP, PPA signed
2005	Mailung	5	4.3	37	IPP, PPA signed
	Middle Marsyangdi	70	70	393	NEA, Under Construction
2006	-	-			-
2007	Langtang	10	10	78	IPP, PPA signed
	Chameliya	30	30	196	NEA Planned
	Kulekhani-3	42	42	50	NEA, Planned
	Khimti-2	27	27	157	NEA, joint venture
2008	Rahughat	27	6	165	Private
	Kabeli-A	30	15	162	Private
2009	Upper Karnali-A	300	300	2133	NEA joint venture
2010	-	-			-

Source: NEA Corporate Development Plan

Table S.2 Supplemental Natural Environmental Impact Assessment Survey

	Items	Purpose	Location	Duration
1.	Water Quality	Sampling of water quality: 9 points Parameter to be measured : 11 Flow velocity (m/s), Discharge (m^3/s), Ambient temperature (^oC), PH, Conductivity, Suspended solids (SS), Dissolved oxygen (DO), Biological oxygen demand (BOD), Total phosphorous (P), Total nitrate (N), and Ammonia (NH3)	① Khani Khola: upstream (UP)of KL II tailrace ② Khani K: downstream (DS) of KL II tailrace ③ Rapti K: 1 km DS of Khani Khola at Tauba ④ Rapti: 0.5 km DS of large slide on Bagihara K. ⑤ Yangran K: 0.8km US of confluence with Kesadi ⑥ Kesadi K: Below confluence of Yanrgran ⑦ Rapti K: Below KL III outlet ⑧ Rapti K: Hetauda/Thanabaran Bridge ⑨ Rani K: UP of Churibagaicha Bridge (Similar)	Each 15days in April (dry season) and August (wet season) 2002
2.	Comparison with Adjacent Catchment	Survey of similar ecosystem in neighboring rivers in the vicinity of KL III to prepare mitigation measures against impacted ecosystem in the case that it is possible that the current ecosystem will be largely changed by KL III in the Khani River and the Yangran Rivers	① Khani River ② Yangran River ③ Rani River (Similar ecosystem)	Each 15days in March (dry season) and June (wet season)
3.	Fisheries and Aquatic Ecology (Insects, Aquatic life and Fish)	Survey of impacts on insects, aquatic life and fish in the Khani and Yangran rivers by taking the water at the Khani headworks and the Regulating dam at the Yangran River	① 300m section between KL III tailrace outlet and the confluence of the Khani and the Rapti ② 1,500m section between the Yangran regulating dam and the confluence of the Yangran and Kesadi rivers ③ Rani River (Similar ecosystem)	Each 15days in March (dry season) and June (wet season)
4.	Fauna and Flora Surveys	Survey of fauna and flora inhabiting in the vicinity of KL III for grasping and assessing the degree of impact on fauna and flora	Fauna: Yangran river basin and Raniriver basin Flora: Yangran river basin All access road and camp area Khani headworks Regulating pond Tailrace outlet Adits and spoil banks	Each 15days in March and June
5.	Downstream Consequence (Release of peak discharge)	Survey of impacts on land use and downstream inhabitants by releasing of $40.1m^3/sec$ from the KL III tailrace outlet in the riverbed of the Rapti River	4km downstream from the KL III tailrace outlet in the Rapti River	Each 15 days in March and June
6.	River Maintenance Flow	Survey of the discharge in dry season and the irrigation water used in the Khani River and the Yangran River to prepare the data for determination of the river maintenance flow in the Khani and Yangran rivers	① 300m upstream from the confluence of the Khani and Rapti rivers ② 1.8km upstream from the confluence of the Kesadi and Yangran rivers	15days in March
7.	Environmental Risk	Survey of possibility of landslide and erosion in the vicinity of KL III since KL III is located at the Mahabarat Range and just upstream of MBT, and there is a possibility of further landslides and erosions	Vicinity of KL III	15day in June
8.	Spoil Disposal	Survey of impact by spoil disposal produced by excavation works of KL III	① Main structure sites ② Spoil areas	15days in June
9.	Dust, Noise and Vibrations	Survey of impacts by dust, noise and vibration during construction of KL III	① Sanutar and Shikaribas villages along access road and base camp ② Bhaisedobahan in the Khani headworks	7days in March and 15days in June
10.	Environment Management Plan	Review of all mitigation and monitoring proposed in the EIA	-	15days in August

Table S.3 Supplemental Social Environmental Impact Assessment Survey (1/2)

	Item	Purpose	Location and Reference Data	Duration
1.	**Resettlement Plan**	**(RP)**		
1.1	Scope of Land Acquisition and Resettlement	Survey of boundary areas showing permanent and temporarily acquired land, identifying Project 'footprints' (camps, quarries, spoil, facilities, etc), land use (including economic, cultural and religious areas of significance) etc. affected by KL III in scale of 1: 5,000. Identify alternate Project sites for minimizing land acquisition impacts.	① Sanutarr and Shikaribas villages along access road and in base camp ② KL III Tailrace outlet, including affected & acquired areas downstream (small temporary bridges, water mills, washing areas, etc). ③ Intake at Bhaise-Dhoban (Hetauda Cement Lease, KL II Boundaries)	30 days in March, 2002
1.2	Socio-economic Information	Updating of existing database of socio-economic information in the vicinity of KL III	Around KL III project area	15 days in March, 2002
1.3	Policy Framework and Entitlement	Survey of policy, framework and entitlement in Nepal for compensation of household, land, crops and trees, displacement allowances and rehabilitation measures, government property and community facilities Entitlement will be followed by Community Consensus Valuation (CCV) process for land compensation rates in KGA.	Kali Gandaki "A"(KGA), Middle Marsyangdi, Arun III, Modi Khola, Kimiti, Bhote Kosia HPPs and Melamchi Water Supply Project (MWSP)	15days in April 2002
1.4	Consultation and Grievance Redress Participation	Survey of consultation, grievance redress participation. Establishment of Village Advisory Committee (VACs) and KL III Environmental and Social Management Unit (KESMU) will be proposed by referring to KGA	VACs of KGA	15days in April 2002
1.5	Relocation of Housing and Settlements	Survey of existing policy for relocation of housing and settlement	KGA experience and policy of Melamchi Water Supply Project and Middle Narsyandi	15days in April 2002
1.6	Income Restoration Strategy	Survey of income restoration strategy for compensation of PAFs/SPAFs by skill training, project employment, and support for funds and income-generating scheme	PAFs/SPAFs in project areas, especially Sanutarr villages along access road and base camp and households affected by KL III tailrace outlet	15days in April 2002
1.7	Institutional Framework	Survey of institutional framework	NEA and Project Levels	15days in March 2002
1.8	Resettlement Budget and Financing	Updating and itemization of budget and financing of resettlement in NEA's EIA	-	15days in June 2002
1.9	Draft Monitoring & Implementation Plan	Preparation of Draft Monitoring & Implementation Plan	-	15days in June 2002
1.10	Spring water and surface water survey	Spring water and surface for utilization of domestic water for villagers on ridges and hills along tunnels and cavern	Amdada, kitini, Kiteni, Nayagaun, Sanutar, Shikaribas, Bokedah akong connection tunnel, headrace tunnel, tailrace and cavern	15days in June and October2002

Table S.3 Supplemental Social Environmental Impact Assessment Survey (2/2)

2.	Social Action Plan (SAP)			
2.1	Skill Development & Project Employment	Survey of skill training and local employment for PAFs and SPAFs; (Community & Stakeholder Consultation for all SAP components)	Project area	Each 15days in March and June
2.2	Agricultural Development	Survey for minimization impacts on the existing 25ha (40 family) irrigated rice fields at Sanutar Village by review of KGA agricultural development program	Sanutar Village (25ha (40 family) irrigated rice fields)	Each 15days in March and June
2.3	Community Development	Survey of community development program by referring to KGA experience	NEA's EIA and KGA experience	Each 15days in March and June
2.4	Community/Public Health & Education Enhancement	Survey of local education and health facilities affected by influx of about 1,000 workers., including program of adequate schooling, sanitation facilities and health clinic (with HIV-AIDs prevention public education, etc)	Project area	Each 15days in March and June
2.5	Rural Electrification	Assessment of current situation and ongoing program for rural electrification in the vicinity of KL III	① Bhainse VDC (Village Decvelopment Committee) ② Basamadi VDC	Each 15days in March and June
2.6	Environment Awareness (EAC)	Survey of habitat destruction and negative effects of slash-and-burn agriculture for education of local community	① Sanutar and Shikaribas villages ② Bokedaha Forest (KL III tailrace outlet)	Each 15days in March and June
2.7	Direct Construction Social Impacts Mitigation	Survey of direct impacts during construction such as spoil, dust, noise and vibration	Sanutar and Shikaribas villages	Each 15days in March and June
2.8	Siren Warning System	Survey of impact by releasing peak discharge of 40m3/sec from KL III tailrace outlet in the Rapti River of 4km downstream from the outlet	Rapti River of 4km downstream from the outlet	Each 15days in March and June
2.9	Trikandi Mandir – Water Release	Possible water release for annual fair at temple complex just below Bhaise-Dhoban.	Bhaise Dhoban, below KLII Powerhouse	Each 7days in March and August

Table S.4 Loan Repayment Analysis (Case 6: Local Loan with Equity Investment and 10 Year Grace Period)

Annual Generation	47.29	GWh
Assumed Real Tariff 2002 Price*	0.0935	$/kWh
Assumed Peak Tariff 2002 Price*	0.1075	$/kWh
Assumed Gate Price 2002 Price*	0.0711	$/kWh
PriceEscal	6.0%	
Exchange Rate US$1=	78.3	Rs

Loan Condition	
Interest Rate per Year	7.5%
Duration (Year)	30
Grace Period	10
Principal Rep	20

Equity		
Total	1,935	mill. Rs.
NEA	1,451	75%
Governm.	484	25%

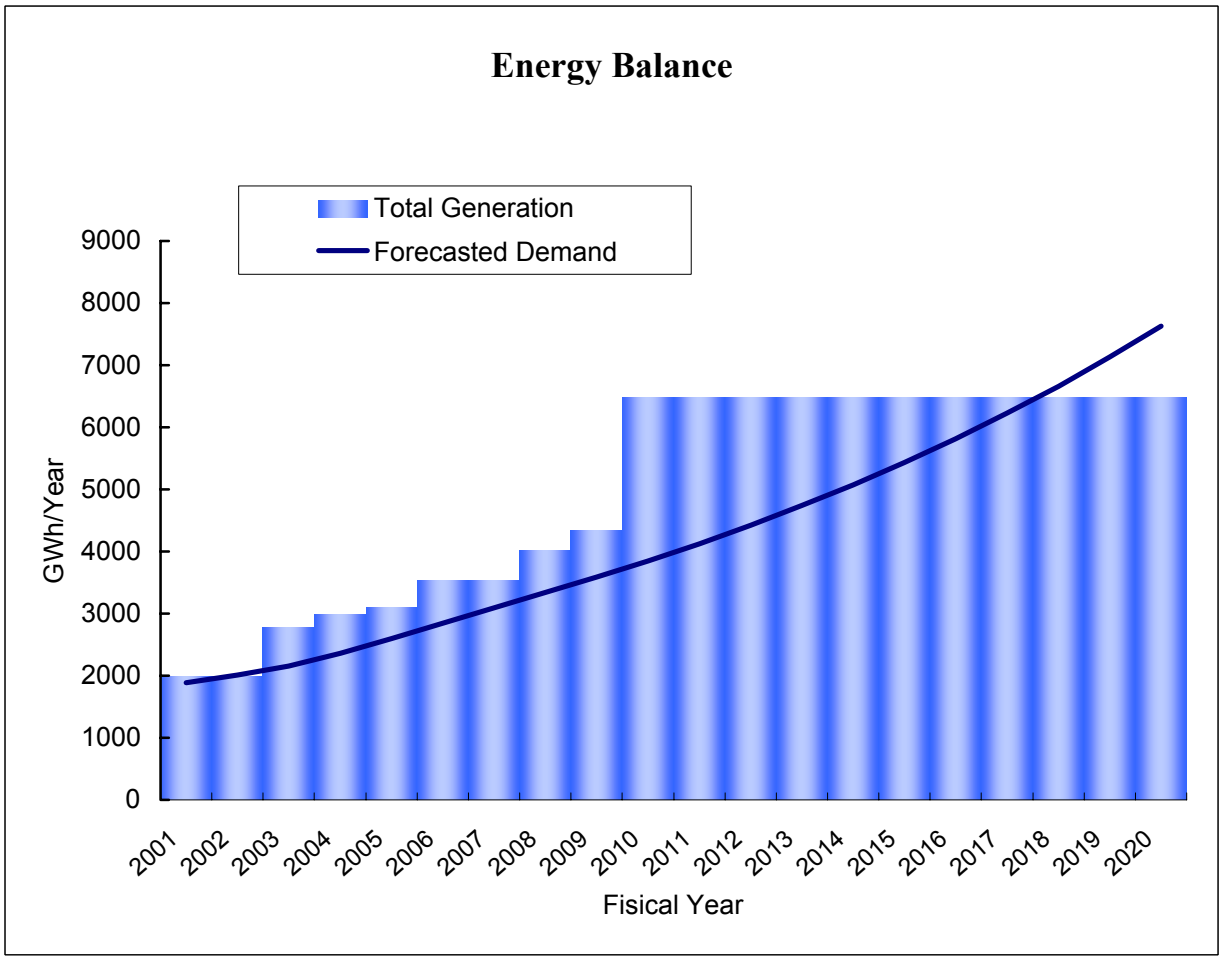
(Unit: mill. Rs in basic)

Year	FY Starting 0	Total Cap. Cost	O&M Cost	Total Cost	Energy Sales Revenue	Net Revenue	Ttl Capital Inflow 6,301	Loan Inflow F 4,366	Equity Inflow 1,935	Ttl IDC 822	IDC 822	Debt Service	Loan Principal 5,188	Loan Interest	Net Cash Flow	Cumulative Cash Flow
1	2004	925		925		-925	925	553	373	41	41	0	0	0	0	0
2	2005	2,225		2,225		-2,225	2,225	1,539	685	157	157	0	0	0	0	0
3	2006	2,508		2,508		-2,508	2,508	1,856	652	296	296	0	0	0	0	0
4	2007	643	32	675	186	-489	643	418	225	327	327	0	0	0	154	154
5	2008		67	67	394	326						389	0	389	-63	91
6	2009		71	71	418	346						389	0	389	-43	48
7	2010		76	76	443	367						389	0	389	-22	26
8	2011		80	80	469	389						389	0	389	0	26
9	2012		85	85	497	412						389	0	389	23	49
10	2013		90	90	527	437						389	0	389	48	97
11	2014		96	96	559	463						509	120	389	-46	51
12	2015		101	101	592	491						509	129	380	-18	33
13	2016		107	107	628	520						509	138	370	11	44
14	2017		114	114	665	552						509	149	360	43	87
15	2018		121	121	705	585						509	160	349	76	163
16	2019		128	128	748	620						509	172	337	111	273
17	2020		136	136	793	657						509	185	324	148	421
18	2021		144	144	840	696						509	199	310	187	609
19	2022		152	152	891	738						509	214	295	229	838
20	2023		162	162	944	782						509	230	279	273	1,111
21	2024		171	171	1,001	829						509	247	262	320	1,432
22	2025		182	182	1,061	879						509	265	243	370	1,802
23	2026		193	193	1,124	932						509	285	224	423	2,225
24	2027		204	204	1,192	988						509	307	202	479	2,704
25	2028		216	216	1,263	1,047						509	330	179	538	3,242
26	2029		229	229	1,339	1,110						509	354	154	601	3,843
27	2030		243	243	1,419	1,176						509	381	128	667	4,510
28	2031		258	258	1,505	1,247						509	410	99	738	5,248
29	2032		273	273	1,595	1,322						509	440	69	813	6,061
30	2033		289	289	1,690	1,401						509	473	36	892	6,953

*: Tariffs in 2002 price are treated as they are based on the past year's average tariff.

FIGURES

Summary



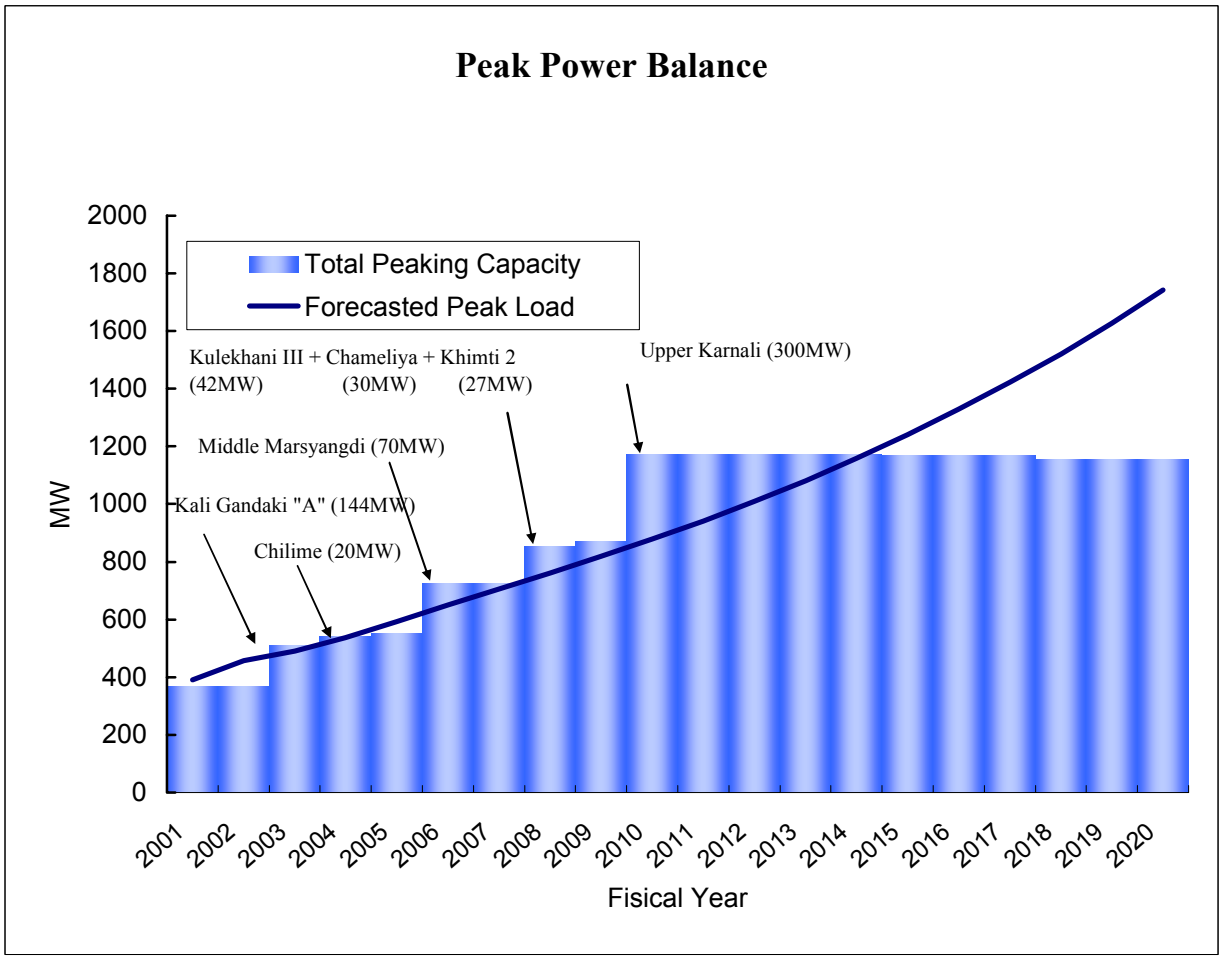


Figure S.1 Power Demand Forecast and Energy/Power Balance

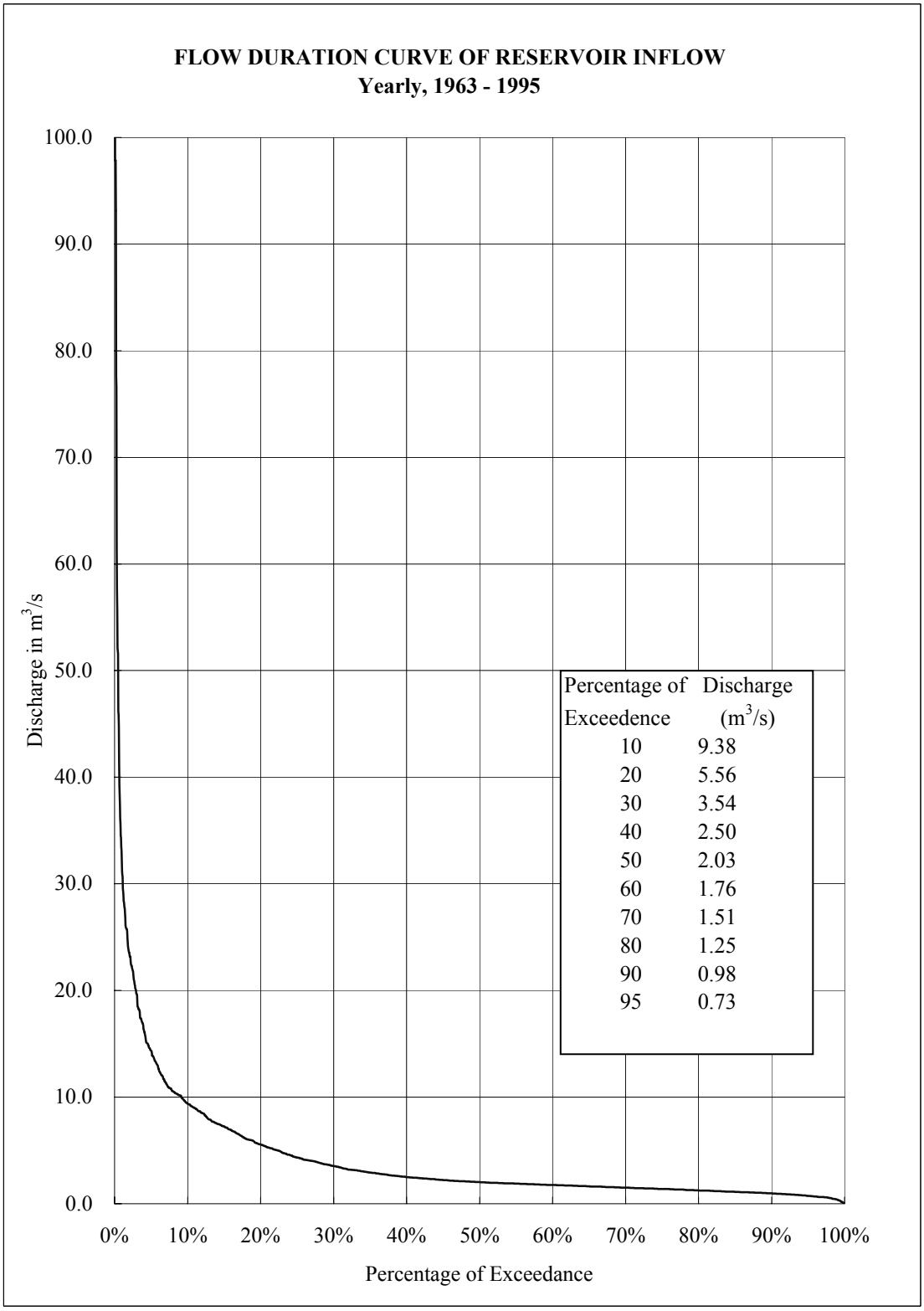
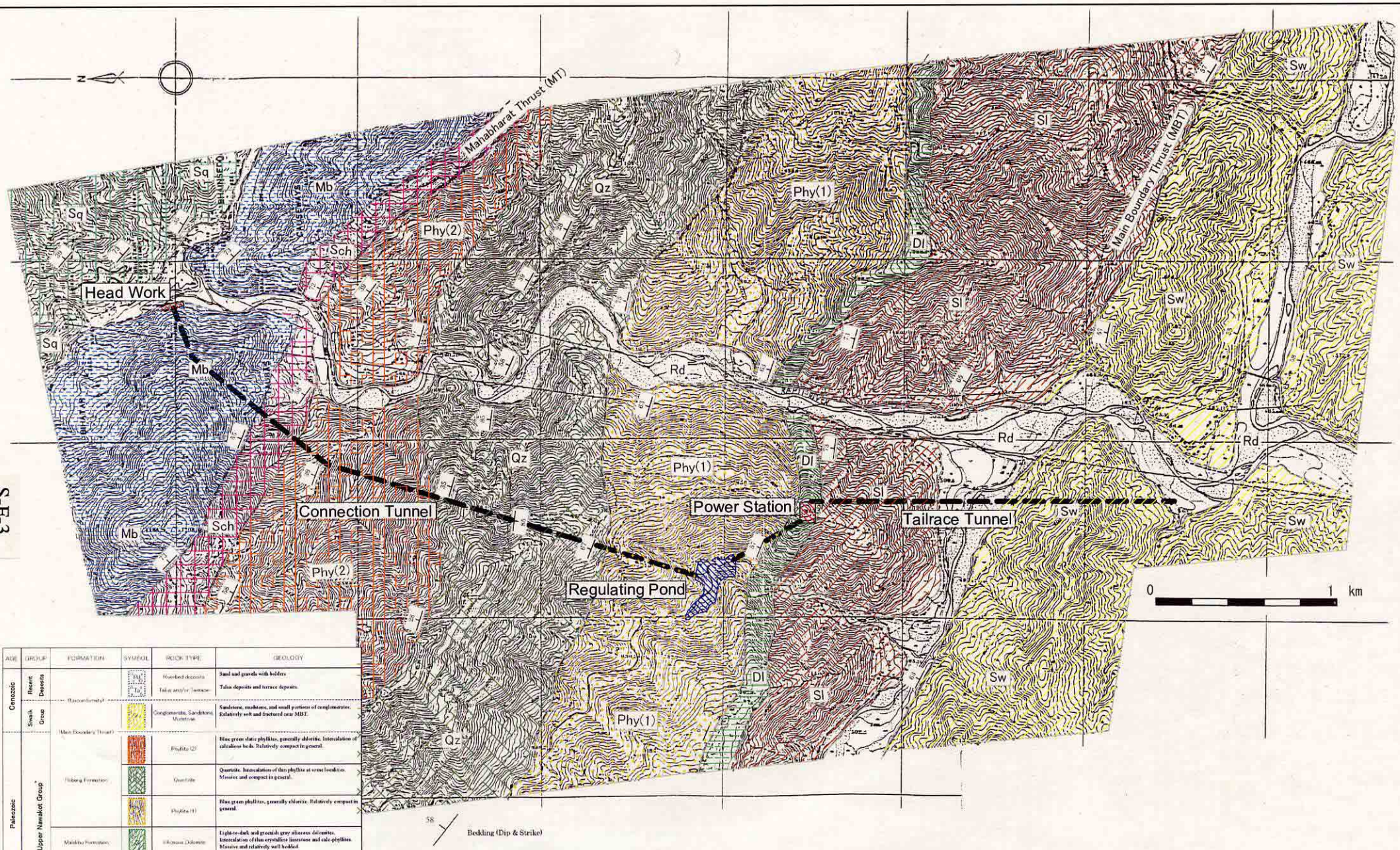


Figure S.2 Flow Duration Curve of Inflow into Kulekhani Reservoir



S-F-3

AGE	GROUP	FORMATION	SYMBOL	ROCK TYPE	GEOLOGY
Cenozoic	Recent Deposits			Riverbed deposits	Sand and gravels with boulders
				Talus and/or Terrace	Talus deposits and terrace deposits.
	Siwalik Group	(Unconformity)		Conglomerate, Sandstone, Mudstone	Sandstone, mudstone, and small portions of conglomerates. Relatively soft and fractured near MBT.
		(Main Boundary Thrust)			
Paleozoic	Upper Nawakot Group*			Phyllite (Qz)	Blue green slaty phyllites, generally chloritic. Intercalation of calcareous beds. Relatively compact in general.
		Robang Formation		Quartzite	Quartzite. Intercalation of thin phyllite at some localities. Massive and compact in general.
				Phyllite (I)	Blue green phyllites, generally chloritic. Relatively compact in general.
		Malekhu Formation		Siliceous Dolomite	Light-to-dark and greenish gray siliceous dolomites. Intercalation of thin crystalline limestone and calc-phyllites. Massive and relatively well bedded.
		Benighat Formation		Slate/Phyllite	Dark gray slates and phyllites together with black carbonaceous slate. Fractured and weathered near MBT.
		(Mahabharat Thrust)			
Pre-Cambrian	Bhimphedi Group	Kalitar Formation		Schist, Quartzite	Dark green to gray colored two- mica and biotic schist with intercalation of quartzite and garnets. Strongly folded and fractured at places.
		Dhaire Dolomite Formation		Limestone	Coarse crystalline marble, limestone with intercalation of thin schist. Marble and limestone are massive and well bedded.
		Raduwa Formation		Schist	Coarse-crystalline, highly garnetiferous mica schist, gneissic schist. Some quartzites are also seen in this formation.

58 Bedding (Dip & Strike)

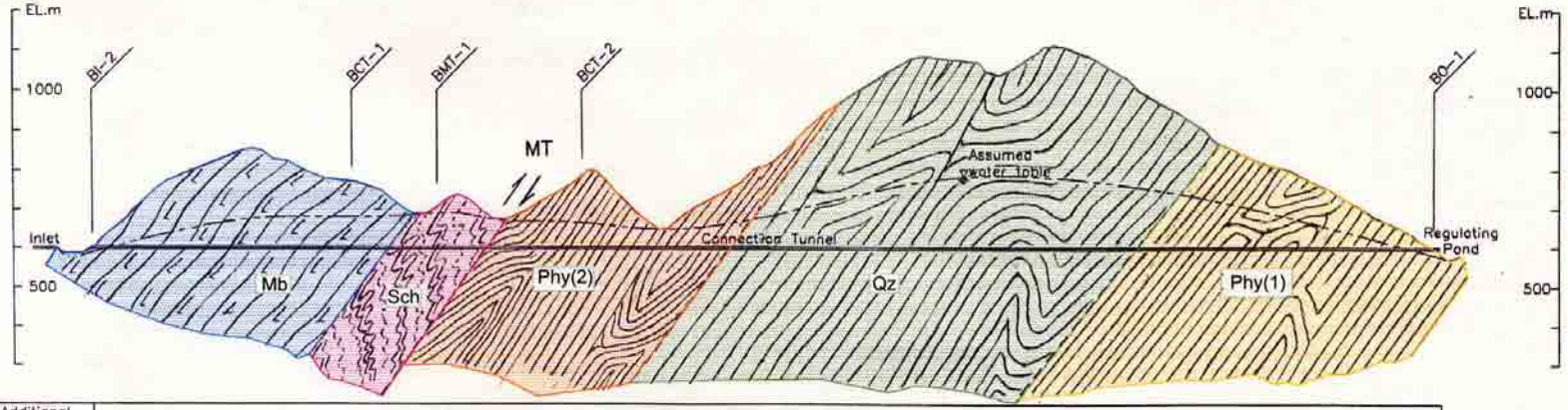
* Mahabharat Thrust (MT):
Considered as an extension of Main Central Thrust (MCT) , which forms the boundary between Higher and Lower Himalayas. Movement of MCT appears to be 5 cm/year in recent years. MT is said to be basement thrust of Kathmandu Nappe which includes Bhimphedi Grou.

* Main Boundary Thrust (MBT):
This thrust forms the boundary between Lower and Sub Himalayas. Siwalik sandstone of folded and faulted Tertiary sedimentary rock have been overthrusted in the south of MBT.

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL

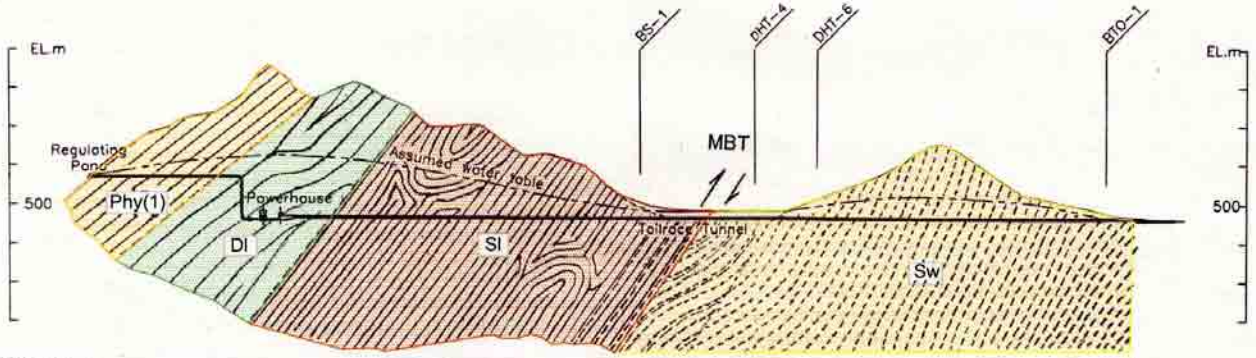
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure S.3 a)
Geology of Project Area
(Geological Map)



Additional Distance (m)	500	1000	1500	2000	2500	3000
Rock Grade (interval)	Q2 (685) / Q4 (60)	Q3 (205) / Q5 (75)	Q3 (590) / Q4 (80)	Q2 (1000) / Q4 (80)		Q3 (705)
Geology	Marble	Schist	Phyllite/ Quartzitic Phyllite	Quarzite		Phyllite
Groundwater	Medium		Large	Large – Medium		Medium

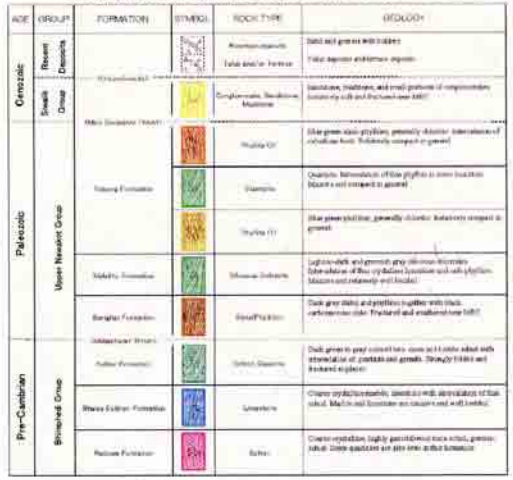
(Inlet To Regulating Pond)



Additional Distance (m)	500	1000	1500	2000	2500
Rock Grade (interval)	Q3 (315) / Q4 (20)	Q2 (265) / Q5 (24) / Q4 (225)	Q3 (250)	Q4 (320) / Q5 (280)	Q3 (1000)
Geology	Phyllite	Dolomite	Slate		Sandstone
Groundwater	Medium	Large			Medium

(Regulating Pond To Tailrace)

Stratigraphy and Engineering Geology of Rocks in Project Area



* Mahabharat Thrust (MT)

Considered as an extension of Main Central Thrust (MCT) which forms the boundary between Higher and Lower Himalayas. Movement of MCT appears to be 5cm/year in recent years. MT is said to be basement thrust of Kathmandu Nappe which includes Nawakot Area.

* Main Boundary Thrust (MBT)

This thrust forms the boundary between Lower and Sub Himalayas. Thrust sandwiches of folded and faulted Tertiary sedimentary rock have been overthrusted in the south of MBT.

0 200 400 600 800 1000m

S-F-4

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure S.3 b) Geology of Project Area (Geological Profile)
JAPAN INTERNATIONAL COOPERATION AGENCY	